Abstracts for the 12th Annual Graduate Student Symposium in Ecology
100 Hunt Hall, UC Davis
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Session I:

Adam Pepi, Graduate Group in Ecology
As temperature increases, predator attack rate is more important to survival than a smaller window of prey vulnerability
Climate change can have strong effects on species interactions and community structure. Temperature-dependent effects on predator–prey interactions are a major mechanism through which these effects occur. To understand the net effects of predator attack rates and dynamic windows of prey vulnerability, we examined the impacts of temperature on the interaction of a caterpillar (Arctia virginalis) and its ant predator (Formica lasioides). We conducted field experiments to examine attack rates on caterpillars relative to temperature, ant abundance, and body size, and laboratory experiments to determine the effects of temperature on caterpillar growth. We modeled temperature-dependent survival based on the integrated effects of temperature-dependent growth and temperature- and size-dependent predation. Attack rates on caterpillars increased with warming and ant recruitment, but decreased with caterpillar size. Caterpillar growth rates increased with temperature, narrowing the window of vulnerability. The model predicted that net caterpillar survival would decrease with temperature, suggesting that A. virginalis populations could be depressed with future climate warming. Theoretical work suggests that the net outcome of predator–prey interactions with increasing temperature depends on the respective responses of interacting species in terms of velocity across space, whereas the present study suggests the importance of effects of temperature on prey window of vulnerability, or "velocity" across time.

Emily Brodie, Graduate Group in Ecology
How does fire shape plant communities in subalpine forests? Notes from my first field season
Climate-fueled changes in snow pack and growing season are increasing sapling density and changing stand dynamics in the subalpine forests of the Sierra Nevada, California. These changes will likely continue in coming years and may contribute to larger and more severe fire events in subalpine forests. Despite predicted changes in high elevation fire behavior, there is no published literature documenting how subalpine understory communities and regenerating tree seedlings respond to fire severity in a Mediterranean climate. To date, we have sampled 7 of 12 subalpine fires selected across the central and southern Sierra Nevada. Analysis of preliminary data shows that post-fire species richness increases with fire severity and is greatest in stands that experience >75% tree mortality by basal area. More data and further analyses are needed to understand how members of the high severity plant community differ from lower severity and unburned plant communities. Regenerating tree seedlings show a much different response to fire.

When compared to unburned forest, tree seedlings are found in greater densities after low to moderate severity fire (25-50% tree mortality by basal area) and lower densities after high severity fire (>90% tree mortality by basal area). We hypothesize that, while conifer seedlings may benefit from the increased light and resources caused by reduced canopy cover after moderate severity burning, high severity fire reduces propagule availability. While more data is necessary to fully elucidate trends in this dataset, it is clear that fire severity plays an important and complex role in shaping subalpine plant communities.

Deniss Martinez and Fred Nelson, Graduate Group in Ecology
Graduate Group in Ecology Diversity Committee: Building common language for equity and inclusion
Both Diversity Committee sessions will build GGE members' leadership in equity and inclusion. This first session will focus on building a common language so that we as a community can continue to build on a good foundation.

Keynote Address
Dr. Asmeret Asefaw Berhe, University of California, Merced
Looking deeper: role of sub-soils in organic matter dynamics

Session II:

Benjamin Rubinoff, Graduate Group in Ecology
Investigating the effects of eelgrass and predation on fouling community composition in a temperate estuary
Connectivity via multiple pathways has increased the spread of non-native marine species. Many of these non-native organisms are fouling species, which include many sessile filter-feeding invertebrates. Despite the abundance and broad distribution of fouling species, few studies have investigated their potential to spread from the initial introduction site into surrounding habitats including seagrass beds. Seagrasses are important foundation species that influence the abiotic environment and can potentially act as a filter against invasion. For example, eelgrass structure can physically reduce flow, lower light availability, and alter water chemistry, affecting the species that are able to recruit into this habitat. Alternatively, the spread of invasive fouling species can be limited by native predators. Native predators can preferentially consume non-native prey, acting as a source of biotic resistance against invaders. This study examined the influence of seagrass structure and predation on fouling community composition and the abundance of non-native species in Tomales Bay, CA. We found that predation altered community composition through species-specific effects. Predation was highest on solitary ascidians, of which, predation was stronger on the non-native species Ciona robusta. The effects of predation slightly differed inside and outside of seagrass; nonetheless, the effects of seagrass on community composition were strong. Settlement plates established inside eelgrass beds

showed more bare space and lower species diversity than plates located outside of eelgrass beds. Differences in the cover of non-native species between predation treatments and across habitats are complex and due to species-specific tolerances. Understanding the relative importance of factors that limit the spread of non-native fouling species is crucial in the face of climate change and additional biological invasions, informing future efforts to manage invasions.

Annelise Del Rio, Graduate Group in Ecology
Combined effects of warming and hypoxia on Chinook salmon physiology and development
Water quality within salmon redds, or nests, can be highly variable. With the progression of global climate change, high temperatures and hypoxia, low dissolved oxygen, may occur more frequently within the gravel rearing environment. We examined how elevated temperature and hypoxia as single and combined stressors affected the survival and physiological performance of developing Chinook salmon. We reared embryos from fertilization to the fry stage in a fully factorial design of two temperatures and two oxygen levels and sampled fish at four developmental stages. Embryos reared in hypoxia developed more slowly, had significantly reduced hatching success, and were significantly smaller at hatch. Hypoxia reared fish also had a significantly higher thermal and hypoxia tolerance. Fish reared at high temperature had significantly higher thermal tolerance, but reduced hypoxia tolerance. These results demonstrate the importance of water management strategies that consider abiotic stressors in addition to temperature to promote survival of early life stage Chinook salmon.

Diego Montecino-Latorre, Graduate Group in Epidemiology
Disease epidemic and a marine heat wave are associated with the continental-scale collapse of a pivotal predator (Pycnopodia helianthoides)
Multihost infectious disease outbreaks have endangered wildlife, causing extinction of frogs and endemic birds, and widespread declines of bats, corals, and abalone. Since 2013, a sea star wasting disease has affected >20 sea star species from Mexico to Alaska. The common, predatory sunflower star (Pycnopodia helianthoides), shown to be highly susceptible to sea star wasting disease, has been extirpated across most of its range. Diver surveys conducted in shallow nearshore waters (n = 10,956; 2006–2017) from California to Alaska and deep offshore (55 to 1280 m) trawl surveys from California to Washington (n = 8968; 2004–2016) reveal 80 to 100% declines across a ~3000-km range. Furthermore, timing of peak declines in nearshore waters coincided with anomalously warm sea surface temperatures. The rapid, widespread decline of this pivotal subtidal predator threatens its persistence and may have large ecosystem-level consequences.

Lea Pollack, Graduate Group in Ecology
Size matters: social group size influences individual behavior
Social context is critically important for behavior. Even something as common as the change in aggregation size or group membership can influence individual and group level behaviors. This

is because the size of a group has the potential to influence the spread of social information, the amount of behavioral variation within the group, and the perception of social information by group members. We looked at how varying group size influences individual behaviors in a controlled experiment with mosquitofish (Gambusia affinis), a model system for social behavior research. We found evidence of a group-size effect: individuals in larger groups were faster to feed on both known and novel food items. Critically, these novel food items included microplastics, a common evolutionary trap for many marine and freshwater species. Our data provides preliminary evidence that group size can influence the severity of a socially mediated evolutionary trap.

Diversity Committee Breakout Session
Promoting leadership by building self-awareness
The Diversity Committee sessions will build GGE members' leadership in equity and inclusion. This second session will focus on understanding our own complex social identities and how these relate to the broader movement of educational equity and allyship.

Session III:

Ann Holmes, Graduate Group in Ecology
Using DNA for diet assessment: Marine invertebrates to mammals (and everything in between)
Diet assessment provides important insight into ecosystem dynamics and function. Traditional diet assessment using dissection has significant limitations: (1) digested prey without hard parts can't be identified; (2) prey identification is usually low-resolution; and (3) prey identification is time-consuming and requires taxonomic expertise, limiting sample size and power of the study. Diet analysis using DNA can overcome these limitations. DNA analysis can identify all types of digested prey, usually with high taxonomic resolution, and is considered a more efficient method for identifying prey. In this talk I will describe how diet assessment can be done with DNA using Illumina high-throughput genetic sequencing and a metabarcoding approach. I will describe standardized approaches that can be applied across a broad range of taxa. I discuss two examples of dietary assessment from completely unrelated organisms in my own research: marine crustaceans and bats. I will also describe important methodological considerations for designing a DNA diet assessment study in just about any organism. As the field of genetic sequencing continues to evolve, DNA diet assessment will become a powerful complement to traditional diet studies

John Mola, Graduate Group in Ecology
What to do when your dissertation is literally on fire
The intention of this talk is to tell my story in conducting my dissertation research while weaving in interesting results. As consumers of scientific knowledge, we often only see projects at their terminus – when the figures are glossy, the title carefully crafted, and the writing is tightly

combed over. However, the process of scientific research can at times be a downright mess. For me, this messy process became obvious when my field research unexpectedly caught fire. Given the new normal of fire regimes in California, it is likely that my experience is or will be shared with many other ecological researchers at all stages.

Frank Fogarty, Graduate Group in Ecology
Fire, grazing, and wintering bird communities in California oak woodlands
Many California bird species have been studied extensively on their breeding ranges, but far less is known about their ecology in winter. In particular, little is known about how potential disturbances such as fire and grazing affect resource use and community structure. Audubon California's Bobcat Ranch, located west of Winters, presented a fascinating natural laboratory to study wintering birds, with its diverse foothills vegetation and both grazed and ungrazed parcels. The reserve also partially burned in both 2016 and 2017, allowing a direct comparison between adjacent burned and unburned areas. This work tested whether alpha and beta diversity or abundances of individual species were correlated with low to medium intensity fire in the previous year, active grazing at the site, and a variety of vegetation characteristics. We surveyed wintering bird communities from Dec-Mar in 2016-2017 and 2017-2018 at 47 sites on Bobcat Ranch. We visited each site three times per season and conducted 8-minute point counts in which we recorded all birds detected within a 100-meter radius of the point center. We also collected a variety of vegetation data at each site. We detected a total of 70 species, 57 of which were detected on point during surveys. We found surprising differences between the factors correlated with alpha and beta diversity. Alpha diversity had a strong negative correlation with fire but our models suggested that those effects were likely to be partially mediated by associated changes in ground cover and vegetation. Grazing did not have a clear relationship with alpha diversity. Modeled alpha diversity was also positively associated with oak (Quercus) foliage mass and heterogeneity in ground cover. Beta diversity was significantly correlated ($p<0.05$) with both fire and grazing, as well as the diversity of deciduous trees present at a site and the percent cover of litter and forbs. Our results showed substantial variation in community composition between sites, even within the same treatment, but that fire, grazing, and vegetation explained significant amounts of this variation. Given projections that the annual area burned in California will continue to increase in coming years, understanding the impact of fire on wildlife habitat is a priority for research. Our findings suggest that fire, while it seems to decrease species richness at the site level, may contribute to higher diversity at the landscape level when it increases the heterogeneity of ground cover and occurs in a matrix with unburned areas.

Poster Session:

Sarah Gaffney, Graduate Group in Ecology
Temporal priority and patch structure influence native suppression of invasive grasses

Maintaining and increasing native grass cover is a common goal in California grassland restoration. When established, native communities can suppress invasion of the noxious weeds goatgrass (Aegilops triuncialis) and medusahead (Elymus caput-medusae), due to their phenological overlap of soil moisture use. However, native grasslands are composed of small-scale vegetation patches, and how the dynamics at the edges of patches influence native spread and suppression of invasives is not well understood. Competitive interactions differ when in the center or at the edge, which may allow less-competitive species, such as goatgrass and medusahead, to persist at the edge and establish in the area. We investigated a) the spatial patterns of native perennials where they were originally seeded and b) how that spatial arrangement of the existing vegetation community, as well as potential temporal priority effects, impacts invasion and spread. 10-year old experimental grassland plots, which were seeded with various mixtures of native, naturalized, and noxious invasive plants, were allowed to be naturally invaded by plants included in the study design, and measured with spatially explicit composition sampling of the plots (centers vs. edges).
Native cover was determined by the original seeding mix, current naturalized annual cover, and plot part. Treatments originally seeded with native species had a very low presence of noxious weeds in either the center or edges of the plot, while treatments seeded with noxious species had low presence of invading natives, suggesting these two groups are direct competitors and will outcompete the other when given temporal priority. Plots seeded with natives had higher Stipa pulchra cover on the edges of plots, while natives Elymus glaucus and E. triticoides had equal cover in the core and edges. Having higher native cover in the edges of a plot compared to the center may aid suppression of noxious weed establishment and spread, as well as be a factor in the spread of natives. However, if the center is being opened up, any species that breaks through the edge may be able to dominate the center, such as naturalized annual grasses.

John Mola, Graduate Group in Ecology
The response of bumble bees to fire revealed via genetic mark-recapture
Fire is a dominant ecological disturbance affecting plant communities worldwide, with increased biodiversity being well-document documented for plant-pollinator populations post-fire. For bees, increased abundance appears driven by a direct response to large increases in floral abundance and diversity in recently burned landscapes. However, the relationship between post-fire environments and pollinator abundance is poorly resolved due to the practical reliance on space-for-time substitutions. For instance, for important pollinators like bumble bees, it is unknown whether the high abundance of foragers following fire occurs from rapid recolonization by many colonies, or the benefit of a few.
Here, we take advantage of a unique opportunity to study the effects of fire in real-time on a ubiquitous bumble bee species (*Bombus vosnesenskii*) by using floral data and genetic samples to examine colony abundance, relatedness, and allele frequency changes before and after fire. We find that abundant plant and bumble bee populations following fire are explained by a large increase in colony abundance, survivorship, and lineage diversity. Furthermore, preliminary

analyses provide evidence for allele frequency changes suggesting either a rapid selection event via induced mortality or relaxed selection by the post-fire environment.
These results suggest that abundant post-fire floral communities can provide a broad resource base to a large and lineage-diverse bee population when compared to unburned areas. Thus, fire can serve as an important tool in maintaining genetic diversity and health of pollinator populations.

Diana Muñoz, Graduate Group in Ecology
Feral horses disrupt greater sage-grouse lekking activity in the Great Basin
Greater sage-grouse (Centrocercus urophasianus; hereafter, sage-grouse) and feral horses (Equus ferus caballus) co-occur within Great Basin sagebrush ecosystems of western North America. In recent decades, sage-grouse populations have declined substantially while concomitantly feral horse populations have increased. Although multiple studies have reported feral horses adversely impacting native ungulate species, direct interactions between feral horses and sage-grouse have not been documented previously. We used Bayesian multinomial logistic models to examine the response of breeding male sage-grouse to the presence of native (i.e. mule deer, pronghorn) and non-native (i.e. cattle, feral horses) ungulates on active sage grouse leks (traditional breeding grounds) during 2013-2018. We found sage-grouse were five times more likely to be on active leks concurrent with native ungulates compared to non-native ungulates. Of the four different ungulate species, sage-grouse were least likely to be at leks when feral horses were present. Our results suggest that the presence of feral horses negatively influences sage-grouse lekking activity. Because sage-grouse population growth is sensitive to breeding success, disruption of leks by feral horses could reduce breeding opportunities and limit breeding areas within sage-grouse habitat. Findings are preliminary and provided for timely best science.

Eliza Oldach, Graduate Group in Ecology
Rockweed in Frenchman Bay: Stakeholder-engaged research on an ecologically and commercially valuable species
Rockweed (Ascophyllum nodosum) is an important canopy-forming species in the mid-intertidal zone of rocky shores in New England. It also comprises 90% of Maine’s 19 million-dollar seaweed industry. As such, the sustainable harvest of rockweed has been identified as a priority by marine resource stakeholders around Frenchman Bay, Maine. Responding to this priority, we studied the ecological role of Frenchman Bay rockweed. We sampled rockweed at sixteen Frenchman Bay sites, examining the extent of the rockweed bed; the size, weight, and age of plants; and the role that rockweed plays in influencing the temperature and light levels in the rocky intertidal. Preliminary data suggest that growth rates are largely consistent across sites, though alga grow larger in the mid and lower bay. While rockweed biomass has profound effects on the physical environment of the mid-intertidal, the effect of harvest on these physical factors and the biological community are not well known. We began a set of simulated harvest experiments, cutting rockweed stands in accordance with the state's 16-inch cut harvest

regulation, to understand impacts of harvest on light conditions, temperature conditions, and community structure in the intertidal. Each component of this project was undertaken in collaboration with marine resource stakeholders of Frenchman Bay.

Julia Owen, Graduate Group in Ecology
Use of noninvasive DNA to study abundance and structure of black bears in the Lake Tahoe Basin
As urban areas continue to sprawl into adjacent wilderness, the number of human-wildlife interactions continue to increase. The American black bear (Ursus americanus) commonly habituates to human resources in regions of urban-wildland interface. Since 1957, the California Department of Fish and Wildlife has relied on bear tags and hunting data as crude indices of regional abundance to inform black bear management. These indices are inadequate for characterizing abundance in smaller problem areas and provide no understanding of bear population structure, such as between urban and wildland habitats. We conducted a pilot study to assess the feasibility of a multi-year noninvasive genetic study in the Lake Tahoe Basin to estimate bear abundance and population structure. We discuss preliminary findings with respect to the efficacy of scat sampling, and estimation of population abundance and structure.

Kyle Phillips, Graduate Group in Ecology
Daphnia magna: Effect of Habitat on Growth and Egg Production
Zooplankton populations in the San Francisco Bay Estuary have steadily declined in recent decades, thereby contributing to declines in local fisheries. High zooplankton densities observed in managed duck ponds of Suisun marsh could potentially subsidize adjacent waterways depauperate of zooplankton. We conducted an in situ growth experiment using field caught Daphnia magna to compare production rates in a managed pond and adjacent slough complex. We observed no significant difference in somatic growth between treatments. However, individuals grown in pond sites produced significantly more eggs ($x = 10.1$, $sd = 1.60$) than in slough sites ($x = 3.16$, $sd = 1.54$; ANOVA: $p = 0.0325$, $df = 8$). Our findings confirm high zooplankton production rates in managed ponds and suggest their capacity for ecosystem subsidy.

Jess Rudnick, Graduate Group in Ecology
Drought as a driver of change? Growers' perceptions and participation in the Sustainable Groundwater Management Act
California's agricultural sector, a major groundwater user, finds itself in the midst of the implementation of the Sustainable Groundwater Management Act (SGMA). The extent of grower participation in SGMA will be a key component to sustainable groundwater management and the agricultural sector's water access in coming decades. We collected data on grower participation in SGMA through 27 semi-structured interviews with growers across California in several priority groundwater basins between 2016-2018. Our analysis investigates relationships

between perceptions and experiences with drought, access to water resources, and participation in the SGMA water governance process. Our results show that physical experiences did not predict grower participation in SGMA. Rather, growers' participation in SGMA appears to be a factor of access to resources and financial and human capital. These results shed light on the potential lack of diverse representation of agriculture in the SGMA process and highlight an area that deserves close attention as groundwater management plans are developed.

Clara Stuligross, Graduate Group in Ecology
Direct and interactive effects of nutrition and pesticide stressors on the solitary bee Osmia lignaria
Bees are threatened by many factors including floral resource limitation, pathogen infection, habitat loss, and pesticide exposure, and they can be exposed to risks across landscapes as they forage widely for pollen and nectar. These drivers rarely act in isolation, and understanding their interplay can have important consequences for pollinator conservation, especially in agroecosystems where limited floral diversity and pesticide use may be at odds with the demands for crop pollination services. We investigated the direct and interactive effects of nutritional and pesticide stressors on the solitary bee, Osmia lignaria. We established nesting O. lignaria females in 16 field cages using a crossed resource x pesticide design; cages contained spring wildflowers at high or low densities, treated with or without imidacloprid, the most widely used neonicotinoid insecticide. Nutrition and pesticide exposure affected bee nesting activity. Bees provided with abundant floral resources constructed more nests than those in low-resource treatments. However, the difference between resource treatments was much smaller for bees exposed to imidacloprid. Pesticides appear to limit bees' ability to take full advantage of the additional resources. Our research is among the first to provide experimental evidence of this nutrition-pesticide interaction, a critical step in understanding mechanisms underlying pollinator health.

Sara Winsemius, Graduate Group in Ecology
The role of fire in shaping subalpine forest structure and carbon dynamics
California's high elevation forests contain a third of the state's carbon, fulfilling an important ecosystem function and service. These regions are often assumed to be reliable carbon sinks, but historic conditions such as low temperatures and persistent snowpack are changing rapidly, resulting in multiple week extensions of the growing season and denser forests due to enhanced climatic favorability for seedling recruitment. Changes in climate are variable across space, however: the central and northern Sierra Nevada has seen a 40-80% decrease in spring snowpack while the higher southern Sierra Nevada has seen no change or a slight increase in snowpack. For regional scales, standard plot monitoring methods lack the ability to describe the spatial distribution of biomass across the landscape or to estimate the change in biomass in response to disturbances. Remote sensing is an essential tool to fill the spatiotemporal gaps and to link changes in ecosystem function and structure to local and regional drivers such as climate and

disturbances. The overall goals of this research are to develop annual estimates of aboveground carbon storage from 1984-present, to quantify the strength and direction of key change drivers and their interactions, and to build a predictive model. Here preliminary research will be presented that begins to answer the question: how does fire impact the carbon balance of subalpine regions?